Special Advisory Panel

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Honorable Deval Patrick
Executive Department
The Commonwealth of Massachusetts
State House
Boston, MA 02133

Dear Governor Patrick:

FINAL REPORT ON STEM-TO-STERN SAFETY REVIEW

The undersigned members of the independent Advisory Panel are pleased to submit this letter report concerning Phase II of the Stem-to-Stern (S2S) Safety Review of the Metropolitan Highway System (MHS). Our charge was to assist the Governor's Office through the Executive Office of Transportation and Public Works (EOTPW) in oversight of the Phase II review of MHS tunnels and facilities and to help ensure that the review was thorough, objective, and effective. This report contains our assessment of the Phase II review and its results, completing our charge as established in Executive Order No. 474 and highlighting items that we believe will require particular and continuing attention to maintain the safety and performance of the system in the years ahead. In brief, the Advisory Panel concurs with the findings of the WJE team and endorses its recommendations for follow-up repair, remediation, and monitoring.

The S2S Safety Review was prompted by a ceiling collapse in the I-90 tunnel of the Central Artery/Tunnel (CA/T) Project and the death of a motorist on July 10, 2006, and the resultant need to restore public confidence in the safety of the MHS. It was conducted in two phases by a consultant team led by Wiss, Janney, Elstner Associates (WJE) with Schirmer Engineering, Inc., and Environmental Systems Design, Inc. Phase I of the S2S Safety Review comprised a 90-day audit, conducted during the fall of 2006, of the structural and life safety systems for the CA/T project, as well as the suspended ceilings of the Sumner, Callahan, and CANA tunnels. It

focused on high-priority safety features that might require immediate remedial attention. At the request of then Governor Romney, the Advisory Panel was convened at the outset of Phase I, and we issued a brief letter report at its conclusion.[1] [2]

Phase II of the S2S Safety Review began on July 1, 2007. It includes follow-up activities related to the Phase I findings; a review of the structural and life-safety system components of the MHS that were not examined in Phase I including the Boston Extension; and special studies of incomplete tendon grouting, concrete overlays, concrete pattern cracking, fire performance of adhesive anchors, tunnel leaks, building leaks, and CA/T ventilation systems.

At the request of Secretary Cohen, the Advisory Panel was reconvened and held its first meeting in September 2007.[3] It met monthly thereafter, usually by teleconference. These meetings included Robert R. Rooney, Deputy Secretary for Public Works and Safety Review Director; Gary Klein, the WJE project manager; other consultants and EOT personnel as required; and occasional participation by representatives of the Office of the Inspector General of the U.S. Department of Transportation (IG-DOT), the U.S. Army Corps of Engineers in its role as technical advisor to IG-DOT, and the Massachusetts Division Office of the Federal Highway Administration. At the conclusion of each meeting, the Panel met in executive session with Deputy Secretary Rooney. Panel members reviewed and critiqued each of the 24 individual reports prepared by the WJE team as well as the team's summary report.

Deputy Secretary Rooney and the WJE team conducted the second phase of the S2S Safety Review in a meticulous and thoroughly professional manner. The Advisory Panel endorses the findings and recommendations of the WJE team, and we have highlighted below several issues that deserve special mention.

- Water infiltration— This topic has attracted much public attention following a breach of a slurry wall in September 2004[4] and media reports of

[1] Advisory Panel letter to Honorable Mitt Romney, November 15, 2006.
[2] Between the completion of Phase I and the start of Phase II, the EOTPW commissioned some immediate follow-up work that addressed the following items: 1. tunnel leaks, 2. Zakim Bridge anchorage plates, 3. seismic design criteria, 4. Sumner Tunnel liner, 5. ceiling anchorage studies, 6. tendon grouting, and 7. concrete viaduct patches. The Advisory Panel was not active during this "Phase IA" work.
[3] The chair of the Advisory Panel during Phase I, Charles D. Baker, declined an invitation to participate in Phase II.
[4] This incident triggered a thorough investigation of slurry wall defects and leaks leading to remediation of 59 major defects in the slurry walls. In Phase I, WJE reported that leakage problems do not pose a short-term safety problem.

"unacceptably high leakage rates." The WJE team has carried out independent inspections, reviewed remedial leak repair methods, and evaluated the measured leakage rates. They find that overall leakage rates for the Central Artery/Tunnel project are consistent with the most stringent U.S. and international requirements for transportation tunnels. They propose implementation of a water management program to maintain accurate records of leakage rates and to ensure timely maintenance for protection of vulnerable structural components and electrical systems.

- TWT ceiling anchors— In Phase I of the S2S Safety Review, WJE emphasized the need for a long-term strategy for future operation and monitoring of the TWT ceiling anchorage system. In accordance with its Phase II work plan, WJE reviewed available construction, inspection, and testing records, and it carried out statistical studies to develop this long-term strategy. As anticipated, in-situ strength and creep testing constitutes a significant part of the strategy. However, there are lingering concerns about relative short tunnel sections with "direct attached ceilings," where it is not possible to inspect or monitor the epoxy anchors. For these sections, WJE recommends either removing the ceiling panels or retrofitting with external stringers.

- Condition of non-CA/T components of the MHS—The S2S Safety Review inspections of MHS components that were not part of the CA/T project identified a number of deficiencies that should be included in firm rehabilitation plans, schedules, and funding. Some items, such as repairs to the concrete liner and suspended ceiling system of the Sumner Tunnel and the suspended ceiling system of the Callahan Tunnel, will be costly and should be included in capital programs. Phase I of the S2S Safety Review, which was completed in November 2006, recommended that an engineered approach to repair the deteriorated liner conditions of the Sumner Tunnel should be developed and implemented within 1-2 years.

- Fire Modeling—As part of the S2S Safety Review, WJE's subcontractor, Schirmer Engineering, has used simulation models to assess the performance of CA/T tunnels during fires. In particular, it modeled performance in fires up to an intensity of 30MW, the 2004 NFPA standard (at the time of tunnel design, the NFPA standard was 20MW). We concur in the use of this 30MW benchmark standard for the S2S Safety Review. The IG-DOT has advocated the use of a much higher 60MW benchmark. For the purposes of the S2S Safety Review, we believe that it would be inappropriate and misleading to model intensity levels in excess of standards in effect at the time the S2S Safety Review commenced. Nonetheless, we believe that fire standards should be continuously reexamined and that modeling the performance of the

CA/T during fires that exceed the 30MW level would certainly be appropriate as part of a broader national assessment of tunnel performance and safety as contemplated by the Federal Highway Administration in its March 5, 2008 proposal to EOTPW.

Looking beyond the S2S Safety Review, the Advisory Panel believes that observations made in its earlier report should be underscored and repeated here. Continued and safe operation of the MHS can only be achieved with vigilant operational monitoring, thorough inspections on regular schedules, and timely maintenance and rehabilitation of any degraded components and systems. In addition, extensive reconstruction and component upgrades will occasionally be required. These are complex undertakings that need careful planning and execution. Reliable and predictable financial resources commensurate with the scale of the system will be required as well as institutional arrangements that clearly delineate authority and accountability. While the S2S Safety Review represents an important and necessary step in ensuring the safety of the system today, the long-term safety presents an operational challenge that is much broader and includes technical, financial, and institutional elements, particularly the following:

- The Massachusetts Turnpike Authority and other agencies with responsibilities for the MHS should prepare and present detailed plans and schedules, including financial and human resource requirements and sources, for addressing deficiencies identified by Phase II of the S2S Safety review, closing out remaining items from Phases I and IA, and performing normal operations and maintenance activities. The EOTPW should be assigned oversight responsibility for the major components of this plan and for monitoring their implementation. These components should include, but not be limited to, repairs and other recommended actions related to the crack in a Leverett Connector bridge pier cap, the concrete liners of the Sumner and Callahan tunnels and their ceiling hanger systems, the ceiling hanger system in the Ted Williams Tunnel, fire suppression in the Sumner and Callahan tunnels, and multiagency training and response for tunnel fires and other tunnel incidents. These components are complex and merit external oversight to maintain operational integrity and public confidence.

- Estimates of long-term operations, maintenance, and rehabilitation costs for the entire system should be revised to reflect experience with urban roadway, tunnels, and bridges elsewhere and to include detailed expected expenditures over time with prudent reserve levels. These estimates should include the costs for periodic, thorough inspections of all components.

- Long-term financial and institutional arrangements should be developed that ensure that the MHS system will operate safely and efficiently indefinitely and that this enormous public asset is properly maintained and renewed as necessary

The S2S Safety Review has achieved its goals. Its comprehensive assessment of the structural and life safety systems of the MHS has in some cases prompted immediate remedial actions. The review and implementation of its recommendations should restore public confidence in this exceptional network of urban highways, tunnels, and bridges. At the same time, the review thoroughly benchmarked the condition of the system, so that an excellent foundation now exists for a continuing program of monitoring, maintenance, and periodic capital projects. If public confidence is to be deserved and maintained, such a program will be crucial.

Very truly yours,

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